Control and Treatment of Viral Respiratory Pathogens

There are many general principles, which can be applied to the control and treatment of any pathogen. However, detailed knowledge of the pathogen is required before solid advice on control and treatment can be given. For this very reason, the current lack of a specific pathogen in Post-weaning Multisystemic Wasting Syndrome leads to good general advice following commonsense. However, the clinician is at a loss to provide any specific advice on control for the medium or especially long term, excluding depopulation, but without a specific agent, repopulation is extremely fraught.

The viral pathogens of the porcine respiratory tract

Table 1

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>Synonym</th>
<th>Potential for elimination (once in a population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenovirus</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>African Swine Fever</td>
<td>ASF</td>
<td>Yes</td>
</tr>
<tr>
<td>Aujeszky's Disease Virus</td>
<td>AD or PRV</td>
<td>Yes</td>
</tr>
<tr>
<td>Classical Swine Fever</td>
<td>CSF</td>
<td>Yes</td>
</tr>
<tr>
<td>Nipha</td>
<td></td>
<td>Yes - probably</td>
</tr>
<tr>
<td>Porcine Circovirus II</td>
<td>PCVII</td>
<td>No</td>
</tr>
<tr>
<td>Porcine Cytomegalovirus</td>
<td>PCMV or IBR</td>
<td>No</td>
</tr>
<tr>
<td>Porcine Reproductive and Respiratory Syndrome Virus</td>
<td>PRRSV</td>
<td>Yes</td>
</tr>
<tr>
<td>Porcine Respiratory Coronavirus</td>
<td>PRCv</td>
<td>No</td>
</tr>
<tr>
<td>Post-weaning Multisystemic Wasting Syndrome (presumed to be a virus)</td>
<td>(Virus? - yet to be identified)</td>
<td>Yes</td>
</tr>
<tr>
<td>Rubulavirus</td>
<td>Blue Eye</td>
<td>No</td>
</tr>
<tr>
<td>Swine Influenza</td>
<td>SIV</td>
<td>Yes and No</td>
</tr>
</tbody>
</table>

Before contemplating treatment and control measures, the clinician should ensure that a proper clinical examination is carried out to determine the presence of the specific pathogen. This should be based on examination of the individual pig (sick and healthy), the group, the herd and the environment (for example buildings). In addition, the clinician should be aware of the routes by which the specific pathogen to be controlled can enter the farm.

**Note:**

For the purpose of this paper enzootic pneumonia is defined as pneumonia associated generally, but not necessarily, with *Mycoplasma hyopneumoniae* complicated with a wide variety of secondary (or tertiary) bacteria including *Pasteurella multocida*, streptococci spp., *Haemophilus parasuis*, actinobacillus spp., *Arcanobacterium pyogenes* and other mycoplasma organisms. It is to be considered synonymous with Porcine Respiratory Disease Complex (PRDC).
## Table 2

### Possible routes of introduction for the major pig respiratory virus pathogens

<table>
<thead>
<tr>
<th>Pathogen</th>
<th>OIE status</th>
<th>Other pigs</th>
<th>Pork products (bacon, sausage, pizza)</th>
<th>Kneaderman (placement of dead pig disposal area)</th>
<th>Transportationsystems</th>
<th>Locality of neighbouring pig</th>
<th>Presence of a major road</th>
<th>Purchased second hand equipment</th>
<th>Clothing from another unit</th>
<th>Birds, Rodents, Cats, Dogs, Pigs</th>
<th>Feeds and water</th>
<th>Feedling and straw (not source of manure for straw)</th>
<th>Staff visiting pig markets, shows and slaughterhouses</th>
<th>Staff owning their own pigs</th>
<th>Vets and other advisors</th>
<th>Visitors (not electricity and gas service people)</th>
<th>New details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adenovirus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African Swine Fever</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aujeszyk’s Disease</td>
<td>Pseudorabies</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Classical Swine Fever</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nipha</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porcine Circovirus II</td>
<td></td>
<td></td>
<td>???</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Porcine Cytomegalovirus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PMWS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRCv</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PRRSv</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rubulavirus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swine Influenza Virus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PRRSv may be transmitted from handling fresh pork products.
Treatment and control of viral respiratory problems

Treatment
Excluding the action of macrolides (Tilmicosin) on PRRSv in alveolar macrophages, there are no antimicrobials that provide any treatment for viral respiratory pathogens. However, as the majority of these viral pathogens exacerbate existing gnzootic pneumonia conditions, antimicrobials may be considered to have a role in minimizing the economic damage and the degree of mortality experienced.

Many viral pathogens result in pyrexia, pain, lethargy and inappetance. The use of non-steroidal anti-inflammatory agents is justified to improve the welfare of the sick pigs. The use of soluble acetylsalicylic acid (10-30 mg/kg) via the water supply for 4 days is generally advised in the face of most viral outbreaks – SIV and PRRSv, in particular.

Control
Control measures are discussed over four degrees. Which level of control is required for each viral pathogen should be discussed by the veterinarian in conjunction with the whole farm health team. Before any control programme can be designed the health team needs to understand the routes by which the pathogen can enter or reenter the farm – table 2.

Control level 1
Pathogens whose clinical expression can be economically ameliorated by the adoption of basic commonsense management practices.
Example viruses – Adenovirus, PCMv, PCVII, PRCv

In the case of Porcine Cytomegalovirus, it appears to be ubiquitous within the pig population, although real studies have not been carried out. The virus is suspected to be present on farms which are negative to other respiratory pathogens. Experimentally the virus causes sneezing mainly in piglets.

The basic management practices are designed to avoid making simple mistakes. For ease of understanding the management practices can be divided into nine areas:

- Biosecurity
- Pig Flow – all-in/all-out
- Medicine
- Environmental – Water
  - Feed
  - Floor
  - Air
- Stock and last but not least Stockmanship.

Each of these areas are examined in turn with a few examples to illustrate how they can interact with or impact on respiratory disease/disorders.
Biosecurity

External biosecurity
Biosecurity is vital to reduce the introduction of new pathogens to the farm. It is essential that producers avoid making any mistake such as moving dirty equipment from one unit to another. This must include vehicle transport between the farm and the slaughterhouse. A review of the biosecurity requirements is an essential component of the veterinary health audit.

Gilt isolation and aclimatization
Adequate isolation is essential to any viral pathogen control programme. The isolation and aclimatization facilities should be run as an all-in/all-out unit.

Internal biosecurity
Enhance internal biosecurity through the thorough cleaning of buildings to minimize pathogen build up. Adopt stringent cleaning programs based around the following cleaning protocols:

- All-in/All-out
- Removal of all equipment where possible and cleaning outside.
- Drainage and removal of all manure and slurry
- Soaking of the room
- Use of detergents to aid cleaning
- Hot pressure washing of all surfaces
- Disinfection which may include lime washing – Calcium carbonate (CaCO₃)
- Drying
- Fumigation
- Preparation of the building for the new group of pigs

Note that all-in/all-out should include not only moving the pigs but having cleaned water supplies, feeders, air and ventilation equipment, floor surfaces and finally medicines, especially needles and syringes.

An essential component of all-in/all-out is that the building is fully prepared for the next group of pigs. For example ensure that the room is warmed for nursery pigs and that the drinkers are at the right height etc. It is no longer good enough to correct these faults a week after placement.

The clinical problems may become severe enough that it may be necessary to contemplate partial depopulation or even a depopulation and repopulation to enable thorough cleaning and modification of the existing facilities.
**Pig Flow**
It is only after a thorough examination of the pig production unit that the ability for all-in/all-out be achieved. Adequate floor space can only be achieved by setting and achieving control of the breeding target, batch after batch of pigs. All-in/all-out must start in the farrowing area. An age spread of more than 7 days at weaning must be avoided and rooms must be filled in one day. All-in/all-out does not occur when a nursery is filled over 3 batches of pigs or from 3 different sources. The last batch of pigs into the flow are effectively continuous flow animals.

![Poor breeding management resulting in empty farrowing crates](image1)

![Pigs of variable age being mixed.](image2)

**Medicine Management**

**General**

Medicines are to be appropriately used.

Keep notes of the relative effectiveness of different routines used in the hospital area.

Between groups of animals dispose of all needles and syringes. Avoid any blunt needles.

Needles and syringes should not be shared between different batches.

**Vaccines**

**Administration**

Vaccines cannot be administered if the pigs are becoming sick. A failing immune system will not respond to vaccines and in some cases it may make the pig’s condition worse as the pig’s immune system has to respond to the vaccine antigens.

Where serious respiratory viral pathogens are endemic – Aujeszky’s or Classical Swine Fever; for example; ensure that these vaccines are stored and administered as according to the manufacturers or governmental advice.
Storage
It is essential to store vaccines appropriately. Several Enzootic pneumonia “outbreaks” have been traced back to frozen refrigerators and inactivated mycoplasma vaccines.

Environmental management
This can be divided into four categories: water, feed, floor and the air. Management of the environment is specifically aimed at reducing stressors.

Water supplies
All drinkers need to work as recommended by their manufacturer and the pig. Pigs must not have to fight over the drinking supply. Ensure the water quality and bacterial loads should be reduced to Public Water Quality standards. The use of water sanitizers has proven extremely beneficial. Note the position of the drinkers must be placed away from the obvious sleeping area. Many pens do not provide clear zones for the pigs’ environment.

Feed
Feeder management
The feeders need to be managed to minimize fighting over feeders. When considering the maximum number of pigs per pen, ensure finishing pigs have access to 7.5 cm of feeder per finishing pig. Follow feeder manufacturer advice and watch the pig’s behaviour with the pen equipment – they are the customer.

Feed quality
Mycotoxins
It is vital to minimize the effects of mycotoxins in the feed. Many mycotoxins have a negative effect on the immune system. Routine cleaning and removal of all mouldy feed from feed bins and feed lines is an essential part of the farms all-in/all-out program at least 4x a year.

Bird and rodent contamination of the feed
Reduce fecal contamination of feed from birds and rodents by clearing up spilt feed, bird proofing the building, and covering the feeders. Rodent control needs to be well maintained with a 1-2 metre open walkway around each building.
Feed ingredients

Enhancement of the immune system through nutritional supplementation shown to be successful on number farms, even though the science behind their use is still being studied.

Floor

Stocking density

It is essential to comply with the legal requirements for stocking densities. Pigs from 80 to 110 kg require 0.65 m², once the average pig weight is over 110 kg EU law requires a floor space of 1 m².

Flooring area

The pig needs to be provided with an area where all the pigs can sleep. Sleep is only really achieved in a draught free zone, which provides a thermoneutral environment – without chilling. Modify the comfort zones within a house to satisfy the pig’s requirements. This may mean that walls have to be moved and pens have to be combined. Smoke rooms to analyze air movement within a building.

Floor consistency

Maintain the floor so that it does not damage the feet and skin of the pig. Damaged feet provide an entry point for pathogens into the pig. Once through the skin, the pathogens rapidly move to the lungs where they can form abscesses and compromise the pig further.
Air and Ventilation
The ventilation system is a major weakness on many pig units resulting in respiratory distress. Areas of ventilation stress that may affect the mucociliary escalatory are vital to avoid.

Temperature
Pigs require to live within their thermo neutral zone and producers need to be aware of the temperature requirements of pigs. On many farms pigs are too hot in the summer due to lack of an adequate cooling system. This places the pig under severe stress and will reduce feed intake. It is essential to follow agreed temperature curves, in particular in the first stage nursery.

Draughts and chilling
Draughts are possibly the number one environmental factor that affects the pig’s ability to fight respiratory disease. Draughts are a serious stress factor affecting the animal’s ability to sleep properly; it is vital that producers provide pigs with zones and in particular a draught free sleeping zone. A draught can be defined as any cold air movement in the sleeping area in excess of 0.2 m/s. Note holes in curtains/walls can result in unexpected draughts.

Farms should utilise remote sensing capabilities monitoring the temperature throughout the day and having the information transmitted via the Internet to a computer terminal for easy analysis by the whole health team. Such systems are available to monitor temperature, humidity, water and feed consumptions – they are vital for early recognition of disease and enhancement of animal welfare.

Gas concentrations
The ventilation system should be maintained to prevent the negative effects of ammonia (below 10 ppm). Ammonia and carbon dioxide can act as an anaesthetic to the mucociliary escalator.

Curtain management
Curtain sided buildings are becoming more common in Europe but need good management. Used properly, they can provide good air patterns through cross flow ventilation. However, it is important to ensure the curtains do not result in draughts. Regularly raise the curtain completely to remove any mice nests. Mice can eat through the curtain and this results in a holes which can lead to draughts onto the pigs. Curtain controls also need to be reviewed. Several systems move the curtain too many times a day resulting in chilling and draughts.
Fan maintenance
Most farms have very poor fan maintenance programs. Producers must be aware that a dirty fan can be 40% less efficient at moving air than a clean fan. This results in poor air quality and variable air patterns throughout the building (as fans can have different levels of dust on their blades which affect their performance). Note the large fans in tunnel-ventilated buildings must have their belts checked and tightened regularly.

Dust
There are three aspects to dust; majority of dust fall in the particle size greater than 3.6 μm. Assuming the respiratory tract is not damaged, these particles are removed before entering the alveolus. Particles less than 1.6 μm will not settle in the alveolus and will move in and out of the respiratory tract. Only particles between 3 and 1.6 μm will enter the lung alveolar tissues. This is important as it means viruses require a “piggyback” to gain entry into the lung tissues and bacteria (generally larger than 3 μm) should be filtered out of the system before entering the alveolus.

Humidity
Low humidity (less than 50%) results in a reduction in particle size and therefore more particles descend deeper into the bronchial tree and these can carry disease agents. Dry air also causes injury to the mucocilary escalator. Moisture over 75% results in a damp environment, which overwhelsms the respiratory defenses.

Stock management
It may be necessary to consider some other options regarding management of the pig themselves.

Streaming – Consider not placing the poorest 10% of pigs into the nursery at weaning. These weaker animals require additional care and a different nutrition from the 90% other higher “quality” pigs. These pigs should not re-introduced to their peers. For this to work adequately, these pigs are placed in separate accommodation.

Hospital pens – care of the compromised pig. When the clinical signs of respiratory disease occur, remove affected pigs to a suitable hospital pen and provide a more comfortable environment and TLC (tender loving care). The removal of these compromised pigs from the rest of the group will reduce the spread of any pathogen.
**Treatment regime** – Adopt a 7 and 14 day rule to compromised pigs. Here the pigs are euthanased if there is no improvement within 7 days. If there is some improvement the pig is given an additional 7 days. If however, after 14 days, the pig has still not recovered completely, the pig should be euthanised. Antibiotics will not stop viral respiratory pathogens, but are essential to treatment of secondary infections.

**Weaner growth rates** – Pay particular attention to detail in the first 3 days post-weaning in training the newly weaned pig where to sleep, eat, drink and defecate. Weaning is an extremely stressful time for the pig.

**Stockmanship**
Well trained, dedicated, enthusiastic stockpeople are essential to the efficient running of a pig farm. The good stockperson must have sufficient time to look after the animals and not spend all their time just running around maintaining the building. Many stockpeople fail to provide sufficient care which is primarily associated with a lack of organisation and prioritising ability.
Control level 2

a) Pathogens whose clinical expression cannot be eliminated by the use of simple management improvements.

Example virus: PMWS (proposed viral cause)

Control of PMWS requires full compliance of control level 1 suggestions.

It is absolutely necessary to adhere to these first principle concepts

However, a few extra ideas may be useful to help achieve adequate PMWS control.

Additional Biosecurity suggestions

In Europe salmonella outbreaks cripple farms weakened with PMWS. It is essential to enhance rodent control and remove transport weak points.

Additional Pig flow suggestions

All-in/all-out is the essential component of PMWS control. It may be necessary to totally review current pig flow targets – considering:

a) the need to decrease the stocking density in the finishing herd – therefore less pigs can be weaned, less sows farrowed and less females served.

b) The need to enhance the health of the weaned pigs – possibly by increasing the weaning age – which has a major impact on pig flow and the possible need to increase the number of farrowing rooms/crates.

c) To reduce secondary pathogen movement between batches, an age gap may be found to be useful. The move towards 3 week batches or some other strict batching concept should be carefully and seriously considered.

Experience indicates that provision of 4-week-old weaners does not confer immunity to PMWS, but it does provide for a bigger piglet at weaning, which manages the stress of weaning easier.

Review the parity profile of the farm. Reduce the number of gilts required as much as possible and ensure that more 3 to 6 parity animals are retained in the herd. This will improve the overall immune status of the farrowing piglets and provide stronger weaners.

Table 3

<table>
<thead>
<tr>
<th>Parity</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3-6</th>
<th>7+</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target %</td>
<td>17</td>
<td>15</td>
<td>14</td>
<td>46</td>
<td>8</td>
</tr>
</tbody>
</table>

Additional Medicine suggestions

Vaccines

Administration

Vaccines cannot be administered between 15 and 60 kg as many pigs with a failing immune system will not respond to the vaccine and, in some cases, it may make the pig’s condition worse as the pig weakened immune system has to respond has to respond to the vaccine antigens. Ensure all vaccines are carried out before 15 kg, but this may prove
especially difficult for some vaccine programs, for example where Classical Swine Fever, Aujeszky’s Disease or Swine Influenza vaccination is practiced in the growing herd.

Storage
If the Circovirus vaccines prove effective, their storage will be a major determinant for their use.

Vaccine timing
Do not vaccinate pregnant gilts and sows with Mycoplasma hyopneumoniae vaccines, as this will increase their colostrum antibodies concentration, which may in turn interfere with piglet and weaner M. hyopneumoniae vaccination.

Antimicrobial use
While PMWS does not respond to antibiotics, (as is it is probably caused by a viral agent), the majority of the secondary agents, which actually result in the death of the pig, are bacterial and these are responsive to antibiotics. Note however, that without an effective immune system, once the antibiotics are removed, the surviving pathogens can still rapidly multiply and overwhelm the pig’s immune system.

Serum therapy
Serum therapy became popular in Europe however, while effective at reducing mortality in the 15 to 40 kg pigs. It unfortunately has proved to only move the mortality problems to a heavier weight at 50+ kg, which is more expensive on the farm output. This practice has now generally ceased.

Additional Environmental suggestions

Water
The use of water sanitizers in Canadian herds –using dissolved oxygen products - has proven very useful in reducing secondary bacterial stressors on pigs with PMWS.

Feed

Feed ingredients
Enhancing the immune system through nutritional supplementation has been shown to be successful on a number farms, even though the science behind their use is still being studied. Most of the nutritional supplements aim to increase available anti-oxidants. Vitamin E and Selenium supplementation are known to enhance the immune system, especially in the weaned pig. The pig does not usually require Vitamin C, as it makes it own, but in some cases increasing Vitamin C in the feed has been beneficial to the sick grower. European and Canadian producers include organic acids, organic Zinc and herbs to enhance the immune system. Work is being undertaken regarding the provision of specific energy and protein balancers. The feed should be of the highest quality and as easy to digest as possible.

Floor

Extra hygiene
Because the previous batch of pigs has suffered PMWS, the background “bugs” will increase. With inadequate cleaning this build up occurs batch after batch. The buildings
and facilities will become progressively more “pig sick”. The use of lime washing helps final cleaning as it graphically illustrates any area of the pen, which is not disinfected.

**Stocking density**
The move towards complying with the legal 1 m² per pig in pigs over 110 kg has reduced the impact of PMWS on European farms, although the high mortality rate will naturally provide more space to the survivors.

**Additional Stock suggestions**

**Hybrid vigor** – Discuss with your genetic supplier the possibility of enhancing hybrid vigor with different boar lines.

Pietrain and Canadian Hampshire pigs have been used in boar lines to good effect in Europe to reduce the clinical effects of PMWS. On many farms the Large White (Yorkshire) purebred boar produces the highest mortality. Note the “resistance” may only be in some lines of pigs rather than all pigs from a specific breed.

**Hospital pens**
When the clinical signs of PMWS start, remove affected pigs to a suitable hospital pen and provide a more comfortable environment and TLC (tender loving care). The removal of these compromised pigs from the rest of the group will reduce the spread of any secondary pathogens.

Antibiotics will not stop PMWS but are essential to treat secondary bacterial infections. Pigs, which survive the 8 week immunological weakness period, will finish, although some will be permanently runted.

**Immunity enhancement** – Piglets born to mothers with a low exposure to PCVII will have lower colostrum antibody levels. Ensure that the background immunity to immune depressing pathogens such as PCVII is raised by good feedback routines. Intentional inoculation of gilts using autogenous vaccines from tonsilar scrape should be considered. Dead PCVII vaccines have been developed, but their effectiveness is yet to be determined. These vaccines are administered to the sow to enhance her colostral antibodies. Obviously, for these vaccines to work it is essential that piglets obtain a sufficient quantity of colostrum.

**PMWS control – take home message:**
All-in/All-out; Reduce stress – the killer; Practice 110% cleaning; Provide the best feed possible and enhance hybrid vigor
b) Viral respiratory pathogens whose clinical signs exacerbate the “pig sick” buildings associated with a high contamination of secondary bacterial disease

The level of the background bacterial pathogens may be so high that control of the viral pathogen cannot be achieved until these background bacterial pathogens are brought under control. The technique most successful at achieving this is a partial depopulation.

The following table provides a timeline for the partial depopulation of a nursery/finishing system – based on the requirements for a farrowing to finish farm. In practice, only depopulating part of the farm, the nursery, for example, does not provide the health enhancement that is required. The principle is to remove all the current stock post-weaning. Then clean all the buildings thoroughly. Repair and refit where necessary the post-weaning accommodation and finally re-clean and ideally fumigate (partially as a terminal disinfectant but also as a mouse control programme) the buildings prior to repopulation with newly weaned pigs.

Table 4

<table>
<thead>
<tr>
<th>Day</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-</td>
<td>Sort out yard accommodation for the finishers</td>
</tr>
<tr>
<td></td>
<td>Purchase cosikennels or make nursery kennels</td>
</tr>
<tr>
<td></td>
<td>Calculate pig flow requirements</td>
</tr>
<tr>
<td>0</td>
<td>Weaning day. Wean all pigs older than 21 days into off-site weaner accommodation</td>
</tr>
<tr>
<td></td>
<td>If normal flow uses 4 week weaning, place weaned sows onto Altrenogest for 7 days.</td>
</tr>
<tr>
<td></td>
<td>Stockpeople working with adults and farrowing house are not to enter finishing accommodation</td>
</tr>
<tr>
<td></td>
<td>All stockpeople working with adult and farrowing houses are to wear clean overalls and boots</td>
</tr>
<tr>
<td>0 - 4</td>
<td>Empty out grow/finish accommodation</td>
</tr>
<tr>
<td>1</td>
<td>Clean out fridge and all tops of bottles. Throw out all out of date medicines. Dispose of all used needles and syringes</td>
</tr>
<tr>
<td>4 - 24</td>
<td>Clean out buildings starting with weaner accommodation</td>
</tr>
<tr>
<td>7</td>
<td>Wean piglets into off-site weaner accommodation</td>
</tr>
<tr>
<td></td>
<td>Move next weeks farrowing sows into cleaned farrowing room</td>
</tr>
<tr>
<td>7 - 28</td>
<td>Repair buildings starting with weaner accommodation</td>
</tr>
<tr>
<td>10</td>
<td>Veterinary Check of cleaning programme</td>
</tr>
<tr>
<td>24</td>
<td>Wash all overalls and boots used by all personnel</td>
</tr>
<tr>
<td></td>
<td>Start re-populating weaner accommodation</td>
</tr>
<tr>
<td></td>
<td>Stockpeople cleaning finishing accommodation are not allowed into farrowing, adult sow or weaner accommodation</td>
</tr>
<tr>
<td>28</td>
<td>All buildings should be functional and ready to accept the pigs</td>
</tr>
</tbody>
</table>

Stockpeople who tend to the grow/finish pigs on the off-site farms are not allowed back onto the farm wearing the same clothes. A complete change of clothing is required to re-enter the farm, after a shower.
Control level 3

Viral respiratory pathogens which enter a naive herd

The actual programme designed by the herd veterinarian must be based on the accepted science regarding the pathophysiology of the diseases caused by the specific viral pathogen under consideration. There are two possibilities, the pathogen may self eliminate, or the pathogen is required to be stabilised and then become enzootic. After post-stabilisation, the farm must practice control level 1 for the ubiquitous viral agents.

a) The pathogen may self eliminate

Example virus: Swine influenza virus

Swine Influenza virus will enter the farm and cause an acute outbreak of coughing and respiratory disease in a range of pig ages. In outdoor units the spread can be slow due to the distance between the different pig groups. It is assumed that given a short period of time, the pathogen will self eliminate from the farm.

Treatment during the outbreak

Maintain pig flow - adults

A swine influenza outbreak will result in pyrexia in adult pigs. This has three major effects:

1. The boar may become partially infertile. This may be permanent, but normally lasts around 6 weeks. Therefore, once the outbreak of swine influenza is recognised, cover all matings on the farm with an AI insemination – obtained from an outside source – which has not experienced a recent SIV outbreak. Note this may result in a biosecurity risk with regard to PRRSv introduction, but this is rare from a commercial AI stud.

2. Do not rush to mate all the sow’s which abort. These sows and gilts must be managed to fill in holes in the farm’s pig flow. On a 250 sow unit, if 10 sow’s abort over a 5 day period and these are mated successfully, the impact will be overstocking in the farrowing house, nursery and grow/finish over the next year – chaos and misery.

3. The fertility of the gilts and sows in the breeding area will be reduced following a SIV outbreak for around a month. Assume a 10% reduction in farrowing rate and breed accordingly and cull at pregnancy checking.

4. If reproductive issues are a concern, ensure that all expected pregnant sows post 28 days are truly pregnant utilizing a real time B mode ultrasound.

Stop feeding the fire

The pigs in the nursery to finishing area

1. SIV moves through the late nursery and grow finish area these pigs are going to slow down and even stop growing for a week to 10 days. During this phase the pigs are going to be increasingly stressed.

2. Pigs will die, often those with chronic Glasser’s disease and weakened hearts with pericarditis. It may be necessary to control secondary pasteurella, streptococci and mycoplasma pathogens. Obviously, with concurrent PMWS issues, a SIV break can significantly disrupt the farm’s health.
3. Sell where possible, even consider underweight pigs. This will improve the stocking density and therefore air quality of the remaining finishing pigs.
4. Raise the ambient room temperatures, particularly at night. However, it is essential to remove draughts and chilling events. Ensure that the water supply is excellent.
5. Review dust levels, especially from feeders.

**Weaned pigs/nursery pigs**

The new pigs about to enter the nursery area are losing any maternal colostrum antibodies (assuming the sow’s have been exposed to this specific SIV varient previously). These pigs will feed the fire. Note, the current farm stock has stopped growing. Therefore a train wreck is about to happen. Ideally sell off farm nursery pigs for at least 2 weeks. This allows the SIV to move through the nursery finishing area and then die out. Alternatively the SIV will be allowed to become chronic on the farm infecting each new naive batch of weaners.

**Control**

**Vaccines**

These are not available within the UK. Where they are used it is important to realise that a vaccinated pig is immune for only 6 months whereas when a natural infection occurs the pig is immune for life.

**Isolation and acclimatisation**

A major source of risk to the farm is the newly introduced gilts. These should be isolated for at least 6 weeks. As gilts are required for each batch and are purchased monthly, at least two isolation areas are required. Unfortunately majority of farms do not even have one isolation area.

**Parity segregation systems**

With larger farms design a parity segregated system. The system works by enhancing the isolation of the gilt. Therefore, if and when SIV enters the farm, the pathogen can be confined to the gilt herd and it has been possible to stop the spread of the pathogen throughout the whole farming system.

b) **The pathogen will not self eliminate**

**Example virus: Porcine Reproduction and Respiratory Syndrome virus**

Abortion is not a primary concern with European strains of PRRSv, but is a serious problem in North America where there are multiple strains of PRRSv, some which are extremely pathogenic.

As PRRSv (or a new strain) enters the naive population the clinical expression is seen as a spike in abortions and the production of weak piglets, many with severe respiratory distress, enteritis and the appearance of being premature. Diagnosis and confirmation of the introduction of PRRSv is achieved by PCR on samples from the infected piglets or serum from aborted or early farrowed sows. It may be useful to sequence the PRRSv virus to help understand the epidemiology of the introduction of the virus to assist in closing the biosecurity breach, which has occurred.
Control is focused on minimizing the timeline of the outbreak and ensuring that the pathogen infects the entire population as quickly as possible and to eliminate the presence of naive subpopulations, which will allow new outbreaks to flare up later.

**Immediate treatment protocols**

**Disseminate the “new” virus around the adult population**
Advise the farmer that more abortions are likely when naive sows become positive. However, these are likely to have aborted in the short term anyway.

1. Medicate all the adults with acetylsalicylic acid (10-30 mg/kg) through the water supply.
2. Feed back to all adults until 15 weeks of gestation. Use macerated materials obtained from the sick and dying piglets from the farrowing house. **Do not provide feedback** to sows due to farrow within 2 weeks or sows in the farrowing house. Ensure that these sows receive feed back at weaning.
3. Using tonsilar scrapes obtained from the aborted sows or sows with weak piglets in the farrowing house make an autogenous vaccine. Inject all sows more than 2 weeks pre-farrowing. **Do not “vaccinate”** sows to farrow within 2 weeks or sows in the farrowing house. Ensure that these sows are vaccinated at weaning.
4. Vaccinate all sows (excluding sows to farrow within 2 weeks or sows in the farrowing house) with a commercial live PRRSv vaccine.

Two to three weeks later
Re-vaccinate adult population with a commercial dead PRRSv vaccine. Note the delay necessary for the sows farrowing and weaned sows.
The purpose of the dead vaccine is to reduce virus excretion from the newly infected herd.

**Pig flow concerns**
Aborted and lactating sows with lost litters
Pig flow can be seriously jeopardized with both sow’s aborting and the loss of litters. Consider the used of Altreonogest (check labeling requirements) to control the reproduction cycles of these pigs and use this control to stablise future pig flow.

**Gilt purchases**
Increase the purchase of gilts. Ideally purchase as a batch, the next 6 months requirements of gilts - through the introduction of a mixed age group. These gilts should be “vaccinated” by tonsilar scrapes from affected positive animals – nursery pigs by the time the gilts arrive.
Then cease new introduction of gilts for at least 6 months to allow the PRRSv virus to stabilise in the adult population.

**Medium term control**

Restore all-in/all-out by good pig flow as soon as possible. Review and enhance biosecurity protocols. Assess the risk of a future breach. If a decision is reached to maintain a PRRSv positive health status, future gilt introductions may require “vaccination” protocols within the isolation and acclimatization programme adopted by the farm health team.

**Control level 4**

Pathogens where the economic impact is such that the pathogen should be eliminated

Pathogen elimination takes two major forms – either it can be achieved without depopulation of the adult herd or requires a total depopulation of all the pigs on the farm. Either way, the cornerstone of any elimination programme is the availability of new genetic material which is free of the eliminated pathogen. Following elimination the farm must adopt control level 1.

a) The pathogen can be eliminated without depopulation

Example virus - PRRSv in an pig free area – no pig farm within 1.5 km of the breeding farm.

The author believes that there is only one long term control programme for PRRSv and that is elimination. However, it is essential that there are no pig farms within 1.5 km of the breeding farm and that a source of PRRSv negative gilts is available and possibly PRRSv negative semen. Ideally on-farm semen collection should be practiced for all PRRSv negative farms. The reader should note that for no good science reason the authors are wary of using serum obtained PRRSv for autogenous vaccine production – it is a matter of personal choice.

**Science Points**

(It is necessary to agree with the farmer certain points of science. Obviously as more knowledge becomes available then these points may in fact be found to be fallacious. For example a longer period of PRRSv excretion may be realized and then the programme needs to be suitably modified. The following programme has been successful in the elimination of PRRSv virus on farms ranging from 200 to 1000 sows.)

No long term carrier status for PRRSv exists in sows or boars.
PRRSv particles are excreted for less than 100 days following infection.
Maternal colostrum antibodies protect piglets less than 14 days of age.
Spread of PRRSv is difficult/unlikely over 500 metres.
It is not present in other animals (excluding some ducks).
**Difficulties**
PRRSv is not excreted in many body fluids consistently. Reproductive problems of PRRSv will/may be accentuated by the treatment advised.

**Technique**
Purchase sufficient young gilts to provide breeding animals for 100 days. Close the farm to all inputs, excluding PRRSv free semen.

**Infect all animals on the farm**
This is achieved by:
- Vaccinate all sows, gilts and boars with a suitable PRRSv vaccine; a live vaccine is acceptable if no previous exposure has occurred. Dead vaccines should be used if animals have been previously vaccinated with a live vaccine.
- Obtain tonsilar scrapes from all animals with acute signs. This is made up to vaccinate all sows, gilts, boars and young future breeding stock.
- Practice feedback of faecal material from acutely ill animals, aborted materials; macerate piglets that die with clinical signs. Feed this material for 14 days.
- At the end of the infection period, throw away all used needles and syringes.

**Farm closure**
For 100 days minimum, the farm must be totally closed (excluding PRRSv free semen).
- All piglets over 14 days of age are weaned off the farm for 100 days.
- Enhance biosecurity measures.

**Clean farm**
At 90 days post-infection, disinfect the entire farm with a suitable disinfectant. Spray the walls, water and air with disinfectant. Wash all clothing and boots. Throw out all used needles and syringes.

**Confirm that PRRSv has been eliminated**
Purchase 20 PRRSv free gilts.
- Introduce gilts into the farm and place the animals all around the farm
- After 21 days, bleed the 20 gilts
- After 35 days, rebleed the 20 gilts.
- If the gilts are negative, declare the farm free of PRRSv and allow the weaning age to increase.
- If any of the gilts are positive, all the gilts are removed. The farm remains closed for another 30 days and the test repeated.

**Post-Control**
All gilts and boars introduced into the farm through an adequate isolation area are:
- PRRSv negative.
- Ideally practice on-farm AI on the farm.
- Do not use a live vaccine on the introduced animals.
- Consider dead vaccine use if proved to be effective.
- Continue enhanced biosecurity measures.
Table 5  
**PRRSv elimination without depopulation timetable programme**

| Week 1 | Infect all sows and boars – dead vaccine and own material from farm  
Ensure all staff well aware of biosecurity measures  
Isolation animals – infect all with dead vaccine and own materials  
Stop live vaccines  
Move materials from the isolation area?  
Purchase new stock for 100 days and ensure all animals are exposed  
Close the herd |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>Continue feed back for 14 days</td>
</tr>
</tbody>
</table>
| Week 3 | Throw away all used needles and syringes  
Start 100 day countdown  
All piglets older than 14 days weaned off farm  
Limit or cease cross-fostering |
| Week 4-14 | All piglets older than 14 days weaned off farm  
Limit or cease cross-fostering |
| Week 14 | All piglets older than 14 days weaned off farm  
Limit or cease cross-fostering  
Disinfect walls, floors, air and water. Vehicles and utensils. Throw away  
all clothing, clean boots, etc. Throw away needles and syringes.  
Order 20 PRRSv negative gilts. |
| Week 18 | Introduce the 20 gilts into the isolation. Order 20 PRRSV negative gilts. |
| Week 21 | Bleed gilts. If negative, go to next week. Move additional 20 PRRSv  
Free gilts into main farm.  
If gilts are positive – immediately remove from the isolation area.  
Close farm for 30 days and re-start checking program. |
| Week 24 | Bleed gilts in isolation and main farm. If negative, go to next week.  
If any gilts are positive – immediately remove from the isolation area.  
Close farm for 30 days and re-start checking program. |
| Week 25 | Start weaning as normal |
| Week 27 | Bleed all 40 gilts again. If negative.  
Restart gilt introduction program  
Declare the farm free of PRRSv |

**b) The pathogen can only be eliminated with depopulation**

**Comment**
Several of the pathogens described (Aujeszky’s Disease (UK), African and Classical Swine Fever and Nipha) are notifiable and no treatment is permitted. A depopulation will be implemented. The depopulation programme will be determined by the government agencies.
There are areas, such as Ireland and Australia, which have maintained a status free of SIV and PRC. Such areas need to ensure that their pig populations are protected from these pathogens. One specific reason is that the accidental introduction of a pig product is likely to bring in several pathogens at once – making the inevitable explosive outbreak of combined pathogens devastating to the local pig economy. The introduction of these pathogens may evoke a depopulation programme from the national government. Strains of SIV which are exotic to a pig area should also be considered foreign and stock introduced from foreign areas should be confirmed free of none native SIV types.

**Example virus – PMWS (proposed viral cause)**

The economic impact of PMWS on many farms is such that depopulation should be considered. The important issue in any repopulation is having a pathogen free source of pigs. While the causal agent in PMWS remains unclear/unknown the source of pigs cannot be claimed to be free. However, several breeding companies around the world have been able to maintain a “free” status – having not experienced any clinical expression of PMWS while PMWS ravaged the surrounding countryside. Likewise, countries which are PMWS negative could consider being the source of breeding stock for PMWS positive countries, especially once the wave of PMWS has gone through the infected farm area.

Farms with clinically severe PMWS have been successfully depopulated and repopulated without the reappearance of PMWS. In the authors own experience this has been attempted successfully five times, with one of the units demonstrating no clinical expression of PMWS over a three year period. The size of the units has been 200 to 2000 sow operations.

**Depopulation and repopulation programme**

Depopulation means total removal of **all pigs and their products** from the farm for the prescribed downtime period

<table>
<thead>
<tr>
<th>Standard down times</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>This depends on the pathogen to be eliminated. For instance with <em>Brachyspira hyodysenteriae</em> it should be a minimum of 8 weeks</td>
<td></td>
</tr>
<tr>
<td>For PMWS restock, 6 weeks would be the suggested minimum</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Depopulation procedures</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Rodent control should start and be vigorous. Place water near baits to encourage intake</td>
<td></td>
</tr>
<tr>
<td><strong>2</strong> Pig Flow – calculate the required pig flow model to allow the farm to legally maximise its output. Aim where possible to achieve all-in/all-out in all parts of the farm, in particular finishing area. Consider all possibilities including batch farrowing to achieve all-in/all-out</td>
<td></td>
</tr>
<tr>
<td><strong>3</strong> Obviously as animals are sold, buildings become empty and they are to be cleaned and repaired as they become empty</td>
<td></td>
</tr>
<tr>
<td><strong>4</strong> Run down all stocks of medicines, feed and disposables</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong> It will probably be necessary to arrange stockperson schedules to ensure that ‘dirty’ stockpeople do not enter ‘cleaned buildings’</td>
<td></td>
</tr>
<tr>
<td>Cleaning protocols</td>
<td></td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>1. Enforce pressure washing and cleaning protocols</td>
<td></td>
</tr>
<tr>
<td>But also note in addition:</td>
<td></td>
</tr>
<tr>
<td>2. Pay particular attention to the removal of all faecal material. The building should be brushed down thoroughly and then dry cleaned using a <strong>knife and scrape</strong> to remove all visible faeces. The small amounts should be removed with a dustpan and brush. <strong>This has to be very thorough and on your hands and knees</strong></td>
<td></td>
</tr>
<tr>
<td>3. Remove dust by vacuuming where possible</td>
<td></td>
</tr>
<tr>
<td>4. Areas of particular note – pigs have long tongues</td>
<td></td>
</tr>
<tr>
<td>Under and around gate posts and gates</td>
<td></td>
</tr>
<tr>
<td>Corners at the back of pens</td>
<td></td>
</tr>
<tr>
<td>Around fittings i.e. farrowing crates</td>
<td></td>
</tr>
<tr>
<td>Under drinkers and troughs</td>
<td></td>
</tr>
<tr>
<td>Where cracks and holes exit in the concrete</td>
<td></td>
</tr>
<tr>
<td>5. <strong>Repair all large cracks and holes</strong> in concrete by</td>
<td></td>
</tr>
<tr>
<td>Cleaning out where possible</td>
<td></td>
</tr>
<tr>
<td>Pouring in a suitable disinfectant</td>
<td></td>
</tr>
<tr>
<td>Once dry repair by screening over with concrete</td>
<td></td>
</tr>
<tr>
<td>6. All wooden partitions and removable objects should be soaked in disinfectant for a period of 3 to 5 days using metal baths. <strong>Place outside in sunlight to dry</strong></td>
<td></td>
</tr>
<tr>
<td>7. Drain and clean the slurry channels and pits. Remove all available faeces. Sometimes this is impractical but it is essential to clean to 30 cm below the removable slats</td>
<td></td>
</tr>
<tr>
<td>8. Ideally lime wash all surfaces especially up to 2 metres high and spray with a suitable disinfectant using a knap sack sprayer into the ceiling and loft areas.</td>
<td></td>
</tr>
<tr>
<td>9. Ensure that the water supplies are adequately disinfected</td>
<td></td>
</tr>
<tr>
<td>10. <strong>Repair all equipment to the necessary standards</strong></td>
<td></td>
</tr>
</tbody>
</table>

**Water**

- Ensure adequate flow is obtainable from all drinkers. This may necessitate replacement of all pipelines. Ensure water pressuring is adequate around the system

**Air**

- Ensure all ventilation systems are thoroughly cleaned. All fans must be checked that they perform as required. Repaint all the blades. Check fan speeds with a tachometer and volt meter

**Floor**

- All floors must be none abrasive. All sharp points are to be removed or covered. Note worn doorways, concrete under water points and around feeders, in particular wet feeding systems. All holes and cracks are to be repaired. Worn rough slats to be repaired or replaced

**Feed**

- Ensure all feeders work as required. All old food needs to be thoroughly removed and sharp edges smoothed. Any holes repaired and if feeders leak and cannot be repaired they must be thrown away. Feed is the major cost and any waste should be avoided

**Vermin**

- Bird proof all buildings where possible – future Salmonella controls

**Cleaning protocols when farm empty**

- Ensure unit perimeter secure
- Finish cleaning the last building
**Dispose of all medicines, needles and syringes. This should include all medicines**

Remove all disposables from the farm, including all feed. Empty all feed hoppers and **feed bins**. Ideally all feed should have been eaten.

**Surfaces**

Ensure all surfaces are cleaned. This must include the refrigerator, chemical store, feed stores, changing rooms and staff room.

**Midden area**

Spread all the midden materials and lagoons and slurry store. The soil within the proximity of the midden area has faeces still remaining from the old unit. Skin off this area to a depth of 80 cm. Spray the soil with a suitable disinfectant and then rescreen over the 80 cm of soil.

**Straw and other bedding**

Old straw remaining from the old unit should be moved and disposed off as this can harbour mice/rats from the old unit.

**Dogs and cats**

Discuss dog and cat protocols. They may require specific treatments depending on the pathogens to be eradicated.

**Tractors**

Ensure all tractors and equipment, in particular muck spreaders and bob cats, are thoroughly cleaned and disinfected.

- Burn all straw and used bedding
- Dispose of all brushes, shovels and scrapes
- Dispose of all overalls, boots and protective clothing
- Purchase clothing for the new clean unit

**Farm clean protocols**

1. Pressure wash all buildings
2. Lime wash all buildings
3. Fumigate all buildings
4. Seal all buildings as each building becomes clean
5. Dispose of all clothing, boots and purchase new when whole farm finished

**Once whole farm fumigated**

1. Restore water supplies and check all drinkers work. Note when water supplies cleaned deposits can block the drinkers
2. Ensure rodent controls are maintained particularly at the perimeter of the farm

**New stock introduction and biosecurity protocols**

1. The new stock require written isolation procedures which are adhered too
2. Note biosecurity requirements these obviously vary depending on the health of the incoming stock.

---

Note – PCVII plays a significant role in the clinical expression of PMWS; however, it is not believed (by the author) to be the primary agent. PCVII is ubiquitous throughout the world’s pig population, although extremely isolated pockets of pigs may be found to be negative to the virus – some island populations. Small short-term study populations have been produced – from positive herds through simple early weaning programmes, however, when these are copied on a larger scale the results have failed. In addition, many nucleus herds were set up by hysterectomy derived techniques which have successfully eliminated other systemic pathogens and these herds have been maintained.
pathogen free, but when examined were found to be positive to PCVII, indicating that long term maintenance is unlikely either because the virus is transmitted in-utero or there are intermediate hosts which are currently unrecognised. The depopulation programme described above eliminated the clinical entity of PMWS, but did not eliminate or change the PCVII status of the farm stock pre or post depopulation, largely because the farm was repopulated with stock positive to PCVII.

**Summary**

Over the years viral respiratory pathogens have presented the pig veterinarian with some unique challenges and opportunities to practice the art of veterinary science.

Many of the pathogens can be controlled by farming programmes that should be adopted on any pig farm as standard practice – (examples - Adenovirus, PCMV, PCVII)

Others provide temporary problems – (example – SIV) – that if properly approached can resolve within a matter of weeks.

Others unfortunately are more insidious, requiring enhanced management programmes to stabilise the farm and restore an economically acceptable output – (examples - PRRSv and PMWS) and in the long term the economic damage may be such that these pathogens may require elimination.

Other viral respiratory pathogens effects are so damaging to the welfare of the pig (examples ASF and CSF) or economically damaging to the farm (AD) that elimination – often at a government’s instance is required.